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EXTENSION BULLETIN

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THE GERMINATION OF GARDEN AND FIELD SEEDS

By VERNON H. DAVIS, Assistant Professor of Horticulture

OUR LITTLE GARDENER

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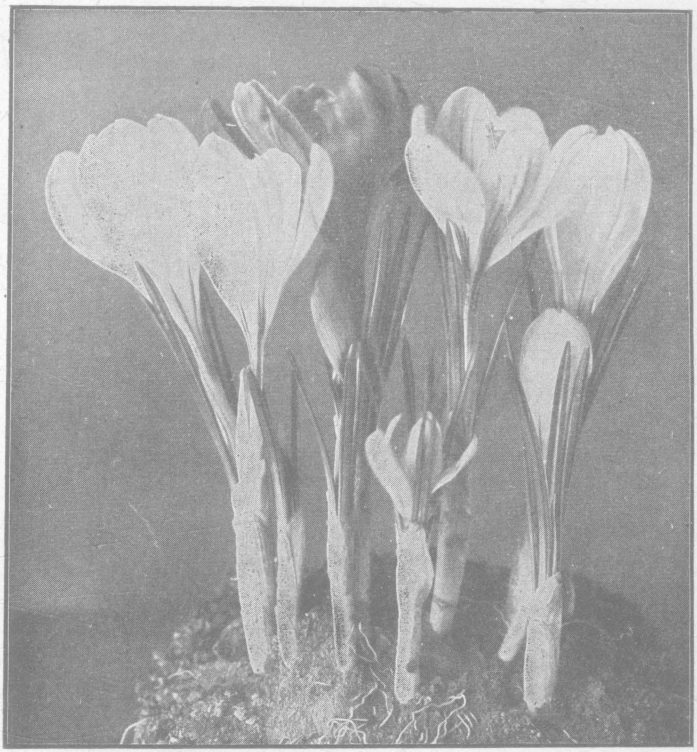


THE CROCUS

Courtesy Livingston Seed Company

THE CROCUS

Warm sunshine came down
On a sweet April day,
To work in the garden
And have a fine play
With the plants that all winter
Had slept there.

He came to a little
Brown bulb at one side,
And said to himself,
"Under this will I hide,
For I see a black cloud
In the sky."

So he tucked himself down
In the soft, yielding earth,
While the little brown bulb
Was just shaking with mirth;
"For the sunshine," said she,
"Makes me grow."

Then down came the rain;
And the bulb that no more
A little brown ball was to be,
Just opened her eyes;
And what do you think?
Why, a bright yellow crocus
Was she.

Germination of Garden and Field Seeds

By VERNON H. DAVIS,
Assistant Professor of Horticulture

On my table are some ordinary pebbles and some beans. They do not differ very much in size, shape, or color. One shows as many signs of life as the other, yet in a few weeks these beans may be living, growing things, full of life with all its mysteries, while the pebbles will not have changed at all or only slightly and these, or similar ones, may be furnishing the food that the beans are building into stem and leaves, flowers, and seeds. Every year, this miracle of nature is repeated over and over again, yet we do not understand fully just why and how these wonderful changes take place. We know nothing of life except as it is manifested through the bodies of plants and animals.

A little Clark county gardner who has experienced the pleasure of caring for a growing plant

With a pocket knife, cut open the bean the long way of the seed. It will be found to consist of two distinct halves—cotyledons or seed leaves we call them. On one of these halves will be seen a very small white body, round and short, with two diverging parts on one end, looking very much like the tail of a fish. Look at these parts closely and they will be easily recognized as tiny leaves. Now with the point of a needle or pin, carefully separate these leaves and a little white projection will be seen between them. We have surprised Nature and

discovered one of her secrets. Here, carefully tucked away in its cover and sound asleep, we have really found a very little plant,—an embryo plant, we call it because, so far, all its growth and development has been as a part of the parent plant from which the seed came. When the warm sun and showers of spring wake it, these two thick halves of the bean will become the first leaves seen above the ground, thick and clumsy, and soon shrivelling away. In the meantime, the short, round white body will have grown down into the soil and formed roots.

These tiny leaves that so much resembled the tail of a fish will develop into the first true leaves of the plant and the little white projection between them will have started its growth into the stem with branches, leaves, flowers, and finally new seeds.

Corn *Bean*

Fig. 1. Grains of corn and beans beginning germination, split to show parts of embryo plant

Lay a corn grain on the table with the furrowed side up and with a knife split it the long way as nearly in the center as possible. Just underneath the seed coat in the furrow and near the point of the grain will be found a small whitish body. The knife will have cut it in two almost in the middle. It is the cotyledon (there is only one in the corn) and makes up perhaps one-third or less of the bulk of the entire grain. Examine it closely and on the upper side just beneath the covering there may be seen two small projections, one directed toward the point of the grain and the other toward the flat end of the grain. The former one will develop the roots, while the latter one will develop into the stalk.*

It will be seen that the corn grain differs from the bean in that it has only one cotyledon or seed leaf instead of two. Again, in figure 1, it will be seen that in the corn, unlike the bean and the other

*While these parts of the seed may be seen with the naked eye in the dry seeds, soaking the seeds for twenty-four hours before using will be very helpful.

seeds of its class, the little embryo plant does not make up the whole seed. The remaining part shown in figure 1 consists of starch, oil, and sometimes sugar, which serves as food for the little plant while it is developing its own roots and getting its leaves to the sunlight.

In the bean, pea, pumpkin, and other similar seeds, this food supply instead of being stored by itself as in the corn grain, is contained with the embryo plant and mainly in the thick cotyledons. It is the plant food in the cotyledons that makes them thick and fleshy. When this food supply is entirely separate from the embryo as in the corn, wheat, rye, buckwheat, and many other seeds, it is called endosperm. It is this stored food supply that makes seeds so valuable as food for man and farm animals. We simply appropriate for our own use what Nature has intended for the little plant. The necessity for this stored food will be seen when we remember that plants cannot use the crude material that comes from the soil and air, except in the presence of sunlight and the green coloring matter in the leaves and stems. Therefore, it would not be possible for the new plant to develop its own roots and get its stem up through the dark soil to the sunlight above without this supply of food ready at hand and ready to use just as soon as growth starts.

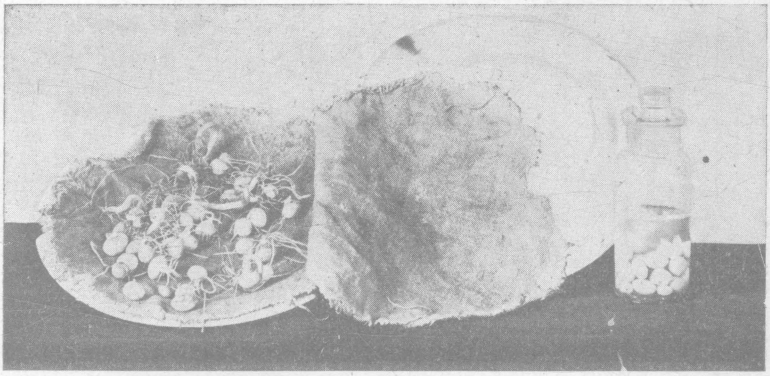
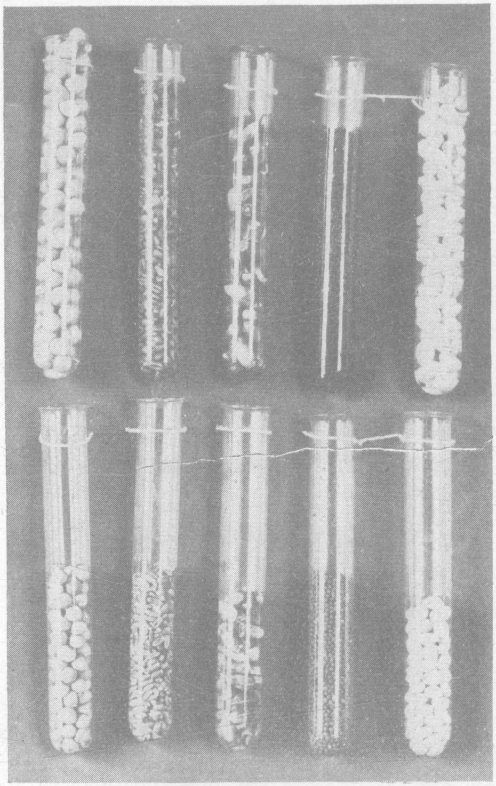


Fig. 2. Home made seed tester containing sproutiug beans. At the right a bottle containing beans covered with water. These failed to germinate because they could not get sufficient air

Place these beans and grains of corn between the moist cloths of a seed tester, such as is shown in figure 2, and place in a warm room. In a short time, the seeds will be seen to have changed greatly. There will be a great increase in size and, in a part of the seeds at least, the seed case will be burst by this tiny round white shoot that we have already seen in both the corn and bean. This shoot always grows downward, no difference what the position of the seed may be, and from it the roots develop,—hypocotyl, we call it because it is always under the cotyledons. The seeds have sprouted, that is, they have taken the first visible signs toward developing into a new plant. Germination is said to be completed when the young plant is able to get its food from the soil and air independent of the seed.

If these seeds had been kept perfectly dry, they would never have sprouted however warm the air might have been around them but as soon as they were placed where they could absorb water and at the same time be exposed to the air and a suitable temperature, they began to sprout readily. This shows that a certain amount of moisture must be absorbed by the seeds before germination can begin. In figure 3 a measure of several kinds of seeds were taken, weighed, and each placed in a separate bottle of water and the bottles placed side by side in a warm room. After twenty-four hours, the water was drained off and the seeds weighed again. The increase in weight was from forty to eighty per cent. and the increase in size was even greater. Most seeds will absorb water at ordinary temperatures very rapidly and in very large quantities. Both the rapidity of absorption and the amount absorbed varies greatly with different seeds and with varying conditions.



Peas *Wheat* *Corn* *Vetch* *Beans*

Fig. 3. Showing increase in size after soaking 24 hours in a warm room. The lower row shows seed before soaking; upper row, after soaking.

Had the tester been placed in a refrigerator instead of a warm room, the seeds would not have germinated. Thus we see that a certain degree of warmth is also necessary to germination. The best temperature for germination varies greatly with the different seeds. The lowest temperature at which the corn and bean will germinate at all is about forty-five degrees F. The highest temperature is about one hundred and twenty degrees while the best temperature is from eighty to ninety degrees. The wheat and peas will germinate slowly at thirty-two degrees and at as high as one hundred degrees but a temperature of seventy-five to eighty degrees will be best. These temperatures refer to the soil in which the seeds are planted and not to the air.

Figure 2 shows sprouting beans in a home-made seed tester and also a bottle in which are some beans covered with water. The seeds were placed in each at the same time and they stood side by side in the same room. Not a single seed in the bottle shows any sign of sprouting and the odor indicates that decay has begun. On the other hand, many

of the seeds in the tester have sprouted and there is no indication of decay. The difference could not have been due to temperature or moisture for both lots had plenty of each. The water in the bottle did keep the air away from the seeds, however, while it had free access to those in the tester. This is probably the reason why seeds planted in wet soils and seeds planted very deeply fail to grow. A few seeds such as those of the rice and some other water plants will sprout and grow under water but the seeds of most plants must be surrounded by a moist medium only, through which the air will freely circulate.

It is evident that seeds require three conditions before they will germinate, viz., a proper amount of moisture, a proper temperature, and a proper amount of free oxygen usually secured from the air but sometimes secured by some seeds in sufficient amount from water.

The quicker seeds germinate after they are planted, the better will usually be the results. As seeds lie in the ground, they are exposed to many dangers. Squirrels, mice, birds, insects, and rot all prey upon them and as the period during which they remain in the soil is shortened so is the period during which these enemies may feed upon them. Again, those seeds that germinate quickest always give the strongest and most vigorous plants. Conditions unfavorable for the germination of the seeds of cultivated plants may be just right for the germination of weed seeds and by the time our tardy cultivated plants reach the surface, they are crowded and smothered by the weeds. Everything possible should be done to get both the soil and the seed in a condition where prompt germination will take place.

In the hurry to get the farm work done, seeds are often planted before the ground is warm enough and dry enough to make quick germination possible. Nothing will be gained and often seed and labor will be lost by planting before the temperature of the soil during the warmer part of the day approaches the temperature at which experience has shown us the seeds germinate best.

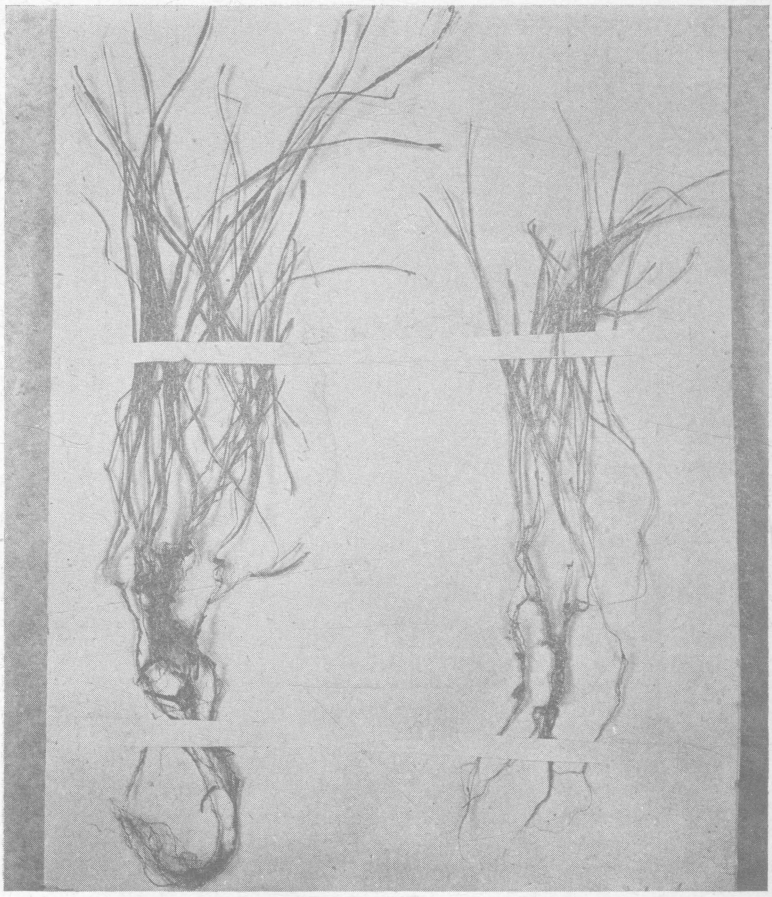
There is a general tendency to plant seeds too deep. No definite rule respecting depth of planting can be given. It must vary with the seed, the soil, moisture, etc. Since the little plant must force its way up through the soil that covers it, the less the depth, other things being equal, the less the energy and time required for the plant to reach the surface.

The general rule may be given that SEEDS SHOULD NEVER BE PLANTED DEEPER THAN IS NECESSARY TO SECURE THE PROPER AMOUNT OF WATER. Very small seeds like the celery, lettuce, tobacco, petunia, etc., should be planted VERY shallow or the young plant will never be able to reach the surface. These seeds are frequently sown and pressed down into the soil without any covering at all, the surface of the soil being kept moist by frequent sprinkling.

Figure 4 shows wheat plants grown from seeds planted one-half inch deep and three inches deep. Compare the stocky, vigorous growth of both roots and stems of the plants grown from seeds planted shallow with those from seeds planted deep.

Compare Figures 5, 6, and 7 and note the difference in the development of the young plant. In the bean and in the pumpkin, the large cotyledons or seed leaves are pulled up through the soil with considera-

ble difficulty. In the corn, the cotyledon with the endosperm remains within the seed coat and just where the grain was planted. The long white shoot easily finds its way up through the soil. Seeds that lift their cotyledons up through the soil must not be planted deeply. While the pea, corn, and wheat will find their way up through several inches of loose soil in many cases, the cotyledons of the large beans may fail to get through an inch of heavy clay soil.



Planted ½ of an inch deep *Planted three inches deep*

Fig. 4. The results from planting wheat, deep and shallow

The time required for germination varies greatly with different seeds. Those of the lettuce and radish will often sprout within twenty-four hours if all the conditions are favorable, while the seeds of some plants cannot be made to germinate the same year they are produced. Individual seeds of the same sample may vary several days in the time required for sprouting. Seeds may fail to germinate for a variety of reasons, even when all the conditions are favorable. They may be too old. While

many seeds retain their vitality for several years, it is generally true that under the most favorable conditions the number of seeds germinating in a given sample gradually becomes less and less every year until their vitality is entirely lost. Some seeds, as the parsnip will rarely ever germinate after the second year. Seeds are sometimes allowed to become too dry. They are sometimes frozen before they become dry. Seeds are rarely ever injured by drying in the air but if dried by artificial heat, their vitality is often impaired. Most seeds will stand any ordinary temperature if they are thoroughly air-dried, but, if not, even slight freezing may be very injurious. Insects and disease may have injured the seeds, either before or after harvesting.

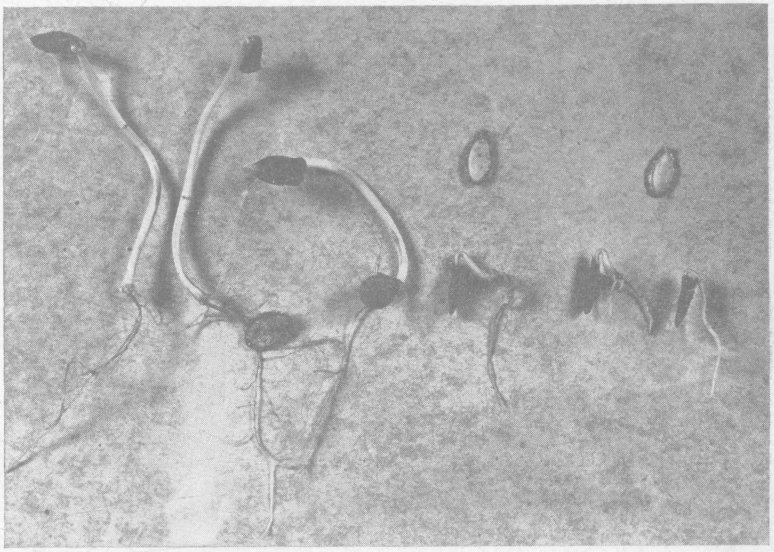


Fig. 5. Pumpkin seeds germinating. Notice how the hook on the hypocotyl has caught one side of the seed case and is pulling it off the cotyledons

Defects of these kinds are not always visible. Therefore, it is highly important that all seeds should be tested before planting. Great loss of time and labor as well as crop loss by a poor stand of plants will frequently be prevented. It is not necessary neither is it always desirable to plant seeds in the soil in order to test them. Figure 2 shows a useful and very satisfactory tester for home use. It consists of two ordinary dinner plates and two circular pieces of canton flannel cloth. The cloths are dipped in water and wrung out until only moderately wet, and spread on one of the plates, with the seeds placed between them. The other plate is then turned upside down on the first one in order to prevent evaporation and the test is started. It may be necessary to moisten the cloths once or twice before the test is completed. This should be done by sprinkling, care being taken to use only as much water as the cloths will readily take up and no more. One hundred seeds should be used in every test. This number will be sufficient to show the per cent. of vitality and the per cent. can easily be figured. The seeds should be

frequently examined and those sprouted removed and a careful count kept of them. For most farm and garden seeds, the test should run ten days but with the grasses, it should be continued at least two weeks. If seventy-five seeds out of a hundred sprout, we say the sample is seventy-five per cent. viable. The temperature of the ordinary living room will be about right for most seeds.

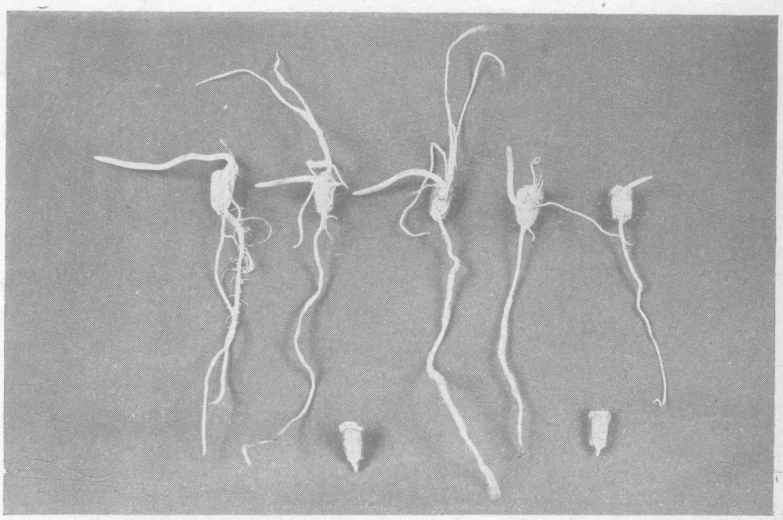


Fig. 6. Corn germinating. Notice the root hairs, visible on some of the roots.

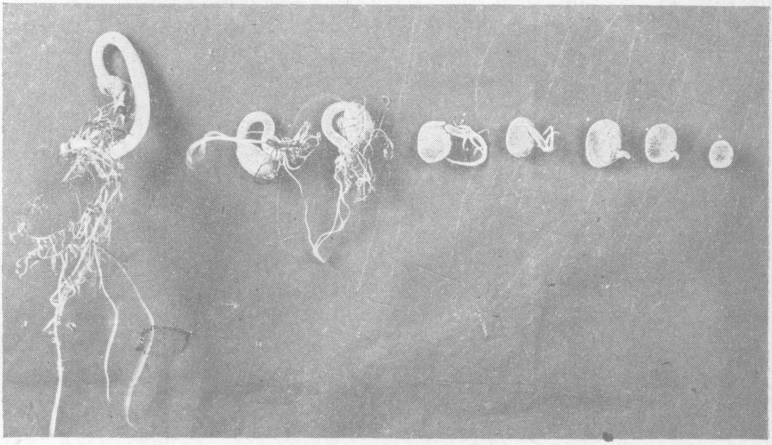


Fig. 7. Beans germinating

Figure 8 shows what is known as the Geneva tester and Figure 9 is one devised by the author but they are more expensive and not so simple or so well adapted to use upon the farm as the one previously described.

The question of the seed supply upon the farm with proper purity and vitality is of first importance and cannot be studied too carefully. Without good seed we can never hope for good plants and good crops and the only way we can be sure of good seed is to carefully test them ourselves.

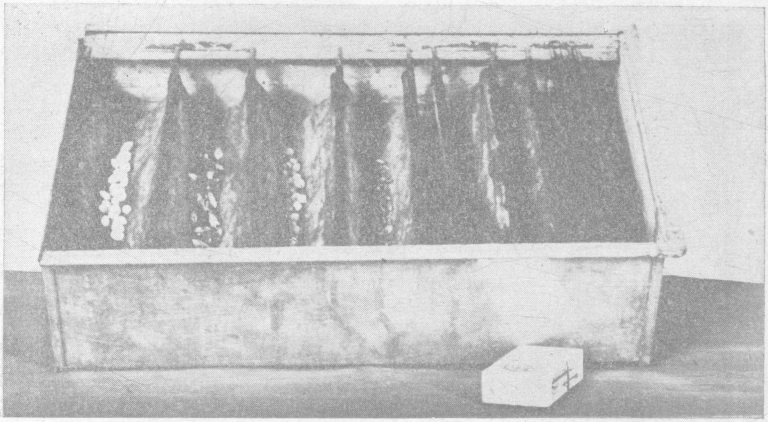


Fig. 8. Geneva Seed Tester

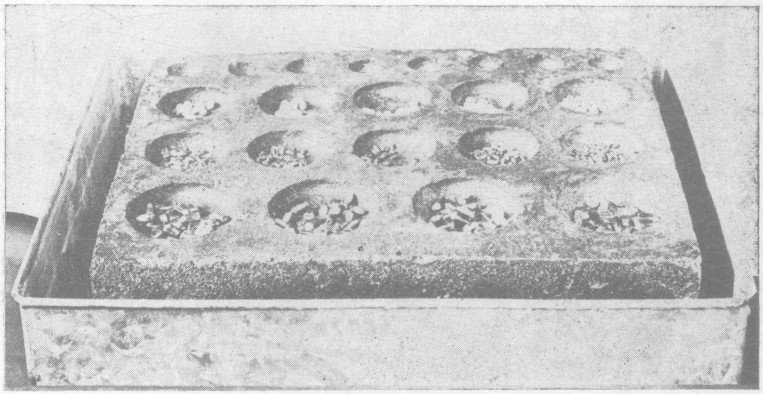
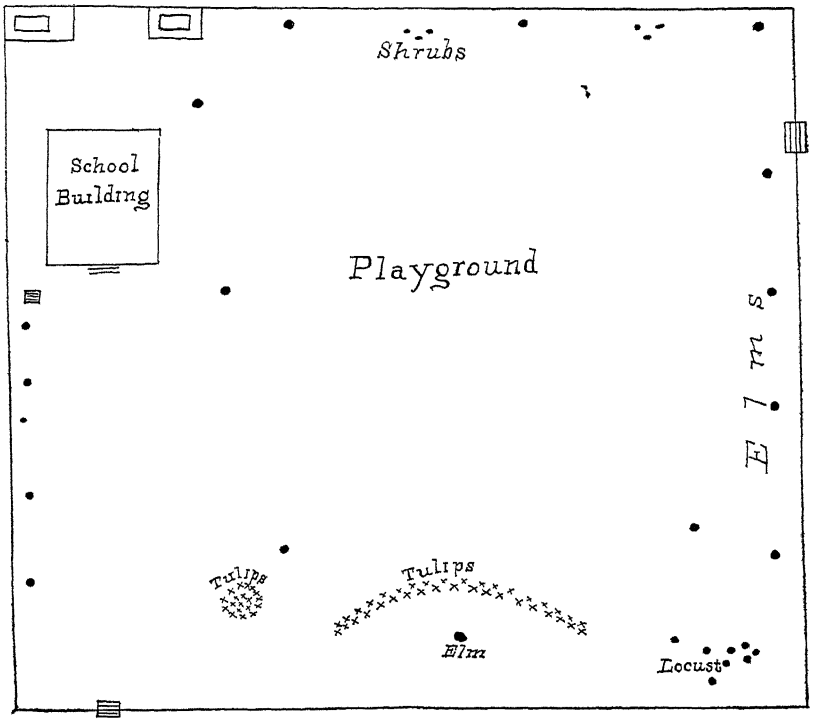


Fig. 9. Tile Seed Tester

HARMONIZE WITH THE SEASON

The time of year has come when there should be a general cleaning up both inside and outside the school room

How inappropriate are last autumn's leaves and the Christmas evergreen during the spring months! How dusty the cat-tails and sedges that have occupied one cozy corner for five or six months! The dust laden festoons of nuts and buckeyes should be consigned to the stove or furnace.



A school ground planted in such a way that the playground was not interfered with

Has the highly colored lithograph a place on our school-room walls. Campaign pictures are not the most suitable for school-room decoration. Vacant desks used for storing away old paper, nutshells, applecores, and many other scraps detract from the appearance of a room. Books thrown into the desk in a way that shows a degree of carelessness tell something of habits that will probably last through later years.

The last dusting of chalk erasers may have added to the already mottled appearance around the front door and under the window sills The slow and steady growth of the ash pile has by this time brought it to its maximum size Neither the rains nor the four winds of heaven will

remove such an accumulation before the opening day of school has come again. It ought to be carted away AND KEPT AWAY that no more remembrance may be had among pedagogues, pupils, or patrons that an ash pile stood as an out-post to the portals of a country school house. The ash pile will not soon be a thing of the past but if the appearance of a school yard is to be considered, its place should not be the most conspicuous.

ARBOR DAY

Proclamations and programs alone never planted trees or shrubs on school grounds. It is altogether proper that a day be set apart for tree planting; however, the best time for planting trees is when not only the children but the fathers and others interested can assist whether that time is on Arbor Day or some time before it.

Seize the opportunity, obtain some trees and spades, and trees will be planted. The most excellent things that have been written about trees, green fields, beautiful streams, and nature's cozy corners should do their part to assist us to see and respond in feeling to the beauties of nature. Let Arbor Day be a time for both sentiment and planting; if either must be omitted for the day, let the sentiment go and plant a tree —not a tiny thing that will require forty years to reach a useful size.

No planting should be done to interfere with the playground. The space directly in front of the house should be left open if possible. Plant to the right and left of the front. Such shrubs as snowball, flowering quince, flowering almond, lilacs, spireas or bridal wreath, sweet clove, and roses should be planted in masses not many feet apart to give the most pleasing appearance.

Climbing roses should be planted near the foundation of the house. Peonies (sometimes called pinies) and all the plants named above bloom before school closes and can usually be secured from those who are doing some thinning and are glad to make such donations. Daffodils (commonly called yellow Easter flowers) tulips, and crocuses should be planted in the fall. These bulbs winter very well and come forth with first warm spring days. (See page 10 of BULLETIN, October, 1906, for table showing time for planting).

A tree or shrub in the hands of a willing boy, who will oil his spade with seriousness, push it into the ground with a weight of determination will make an Arbor Day that will be long remembered.

The people should build a protecting fence of public sentiment so high that neighbor Indifferent's horse and cow cannot jump it, so tight that Cold-Water Pourer's hogs cannot creep under and lock the gate so tight that the school ground cannot become the camping place for all the Doolittles.

Summer School

Courses in Elementary Agriculture and Manual Training will again be given in the Summer Term at the Ohio State University, beginning June 24. Address the Secretary of the University Faculty, O. S. U., Columbus, Ohio, for Summer Term Announcement.

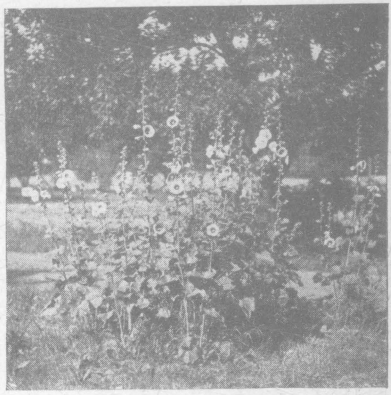
NOTICE

Any teacher who now receives this BULLETIN and wishes to have his name placed on the mailing list for NEXT YEAR, should write at once or as soon as he has determined his post-office address. In changing address, give both old and new address.

Members of Agricultural Clubs and pupils now receiving this BULLETIN will have their names continued without action on their part.

A. B. GRAHAM,
Superintendent of Agricultural Extension.

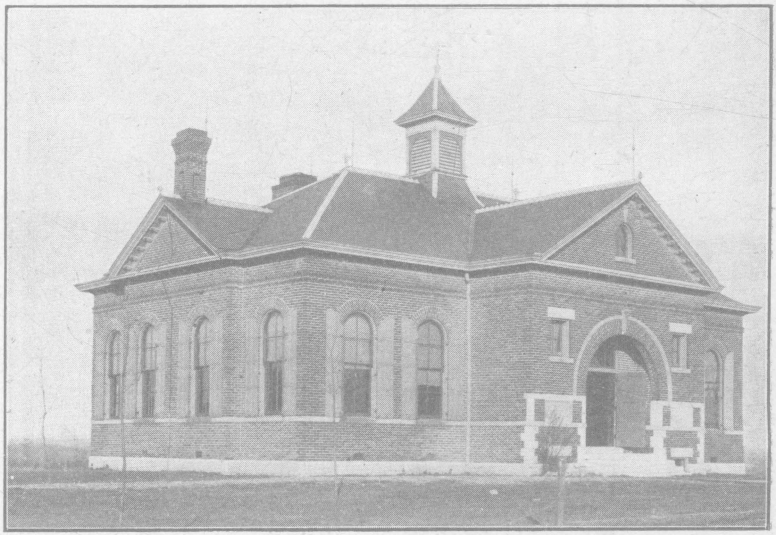
Plant dahlias now for fall blooming



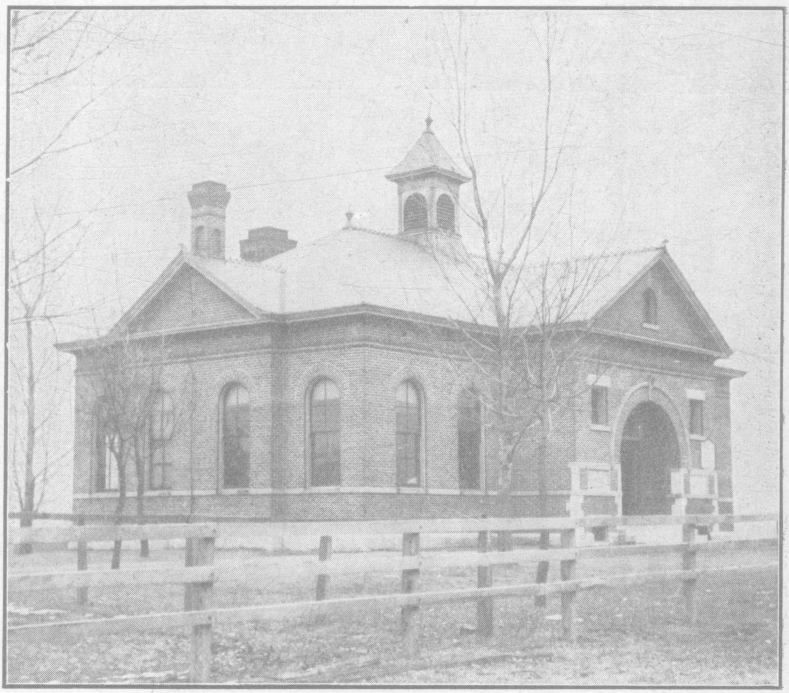
The hollyhock is common but very pretty

Flowering almond for spring bloom

Castor bean for autumn foliage



Trees on Bethel township (Miami Co.) High School ground in 1897



Same ground in 1907